

Systematics and Bias Studies for Dark Energy Survey Supernovae

Joe Bernstein (Argonne National Lab)

Rick Kessler (University of Chicago)

Steve Kuhlmann (Argonne National Lab)

Hal Spinka (Argonne National Lab)

for the Dark Energy Survey Collaboration

AAS January Meeting

Long Beach, CA

2009-01-07



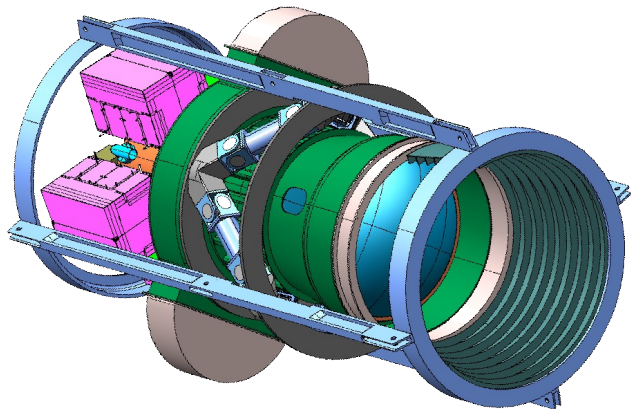
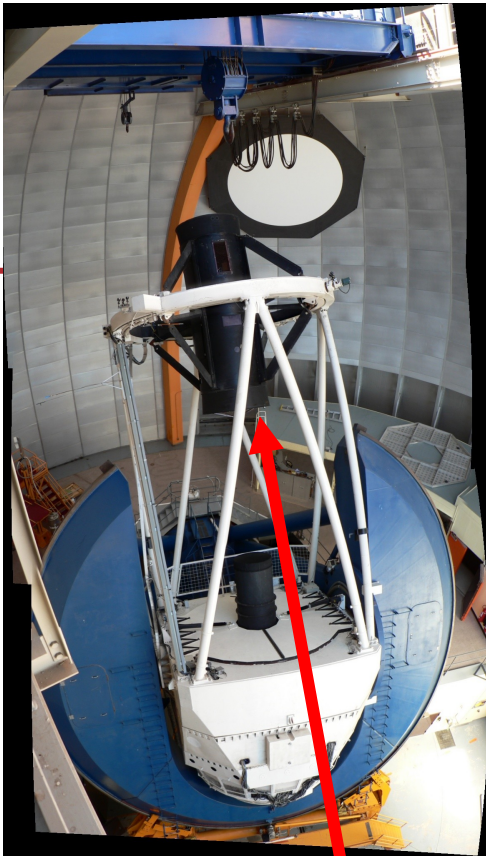
Outline

- Introduction to DES
- SN light curve simulating & fitting
- Default survey forecast
- Selection bias & simulated efficiency
- Spectroscopic strategy & photometric redshifts
- Cosmology fits
- Systematics studies
- Conclusions

Dark Energy Survey (DES)

...nco 4m telescope in Chile in exchange for 525 survey nights

DES uses thicker CCDs from Lawrence Berkeley National Laboratory with increased red sensitivity



SNANA: Simulating DES SNe Light Curves

R. Kessler (U. Chicago), J. P. Bernstein, S. Kuhlmann, & H. Spinka (ANL)

- Generates SNe using variety of models (e.g., MLCS2k2 & SALTII)
- Also used by SDSS and LSST
- Publicly available: http://www.hep.anl.gov/des/snana_package
- Provides for an accurate & complete study of DES SNe including
 - application of random color/luminosity fluctuations
 - host galaxy dust extinction
 - application of K-corrections
 - a choice of cosmologies
 - application of Milky Way dust extinction via Schlegel maps
 - CCD gain, noise, and sky noise
- Uses survey zero-points to convert magnitudes to flux

MLCS Fitter included for resulting light curves

Current Favored DES Supernova Fields

Chosen to maximize:

- visibility from DES site
- past observation history
- visibility from, e.g, Hawaii
- potential overlap with VISTA IR survey

Chandra Deep Field – South ●

Sloan Stripe 82 ●

SN Legacy Survey (SNLS) D1 ●

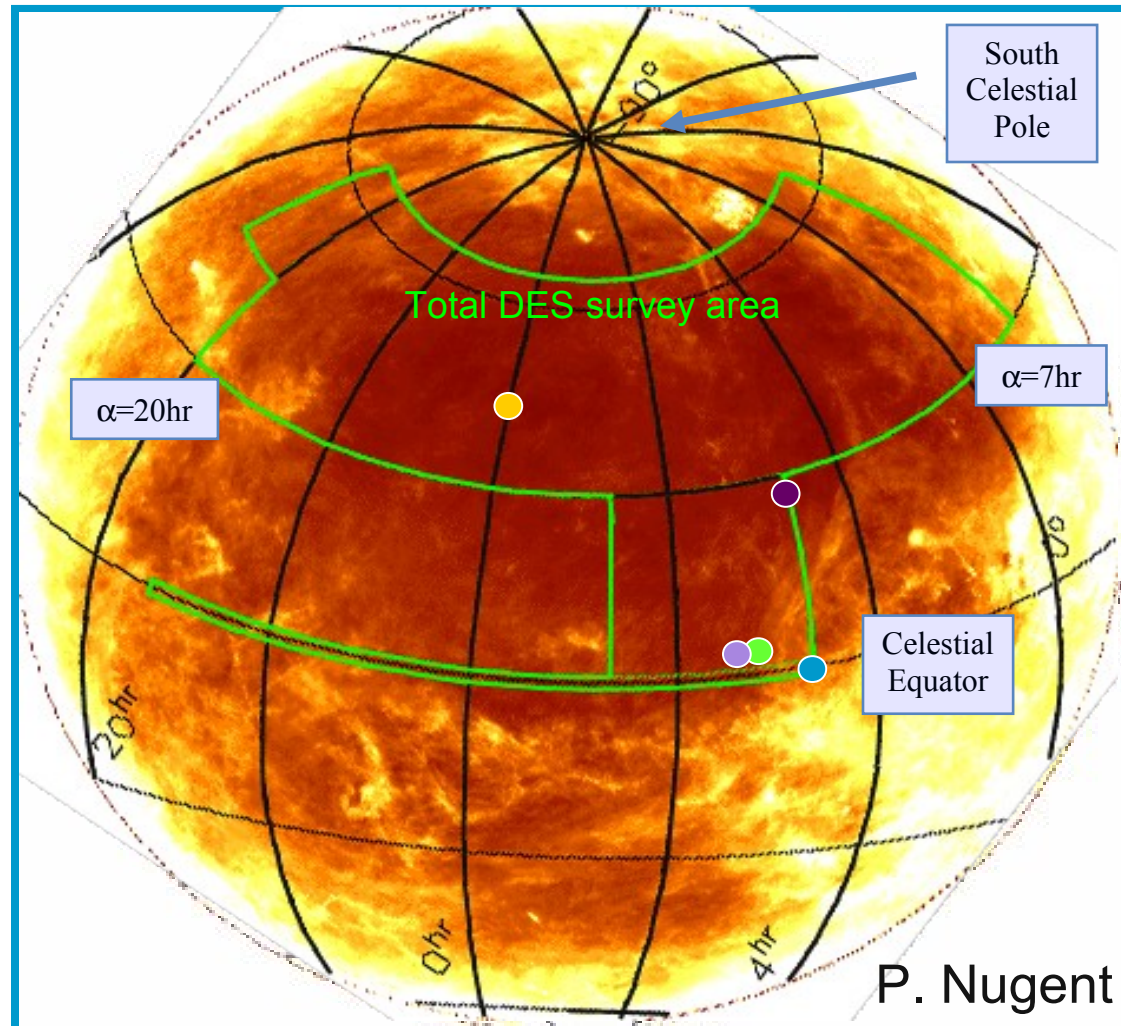
XMM-Newton LSS ●

ELAIS S1 ●

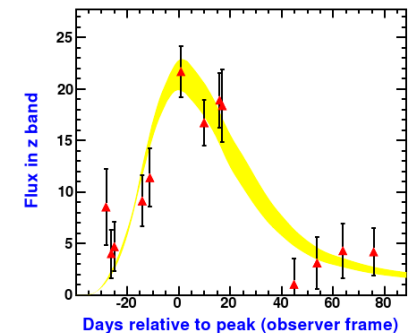
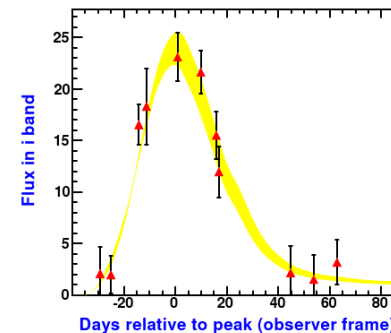
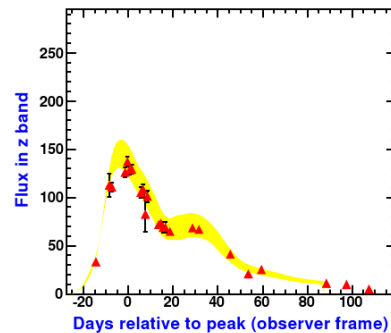
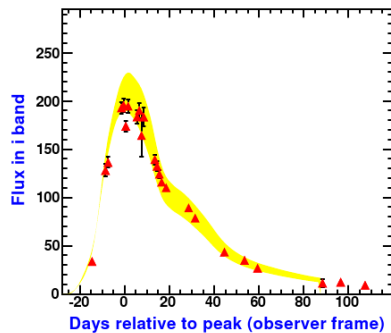
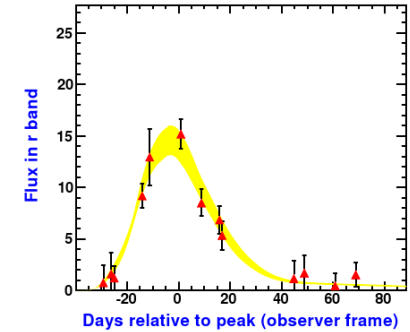
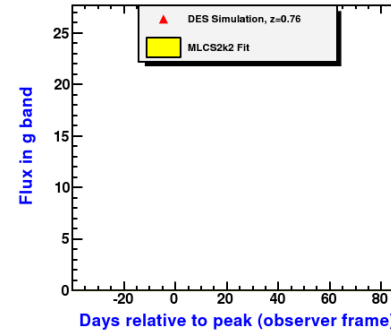
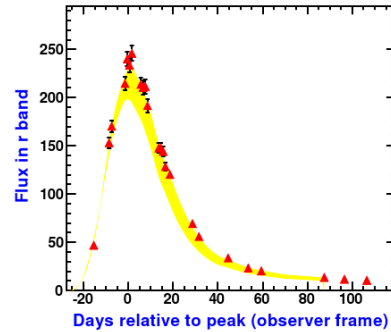
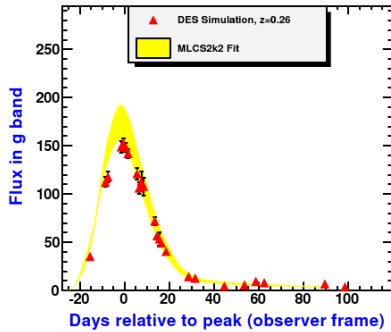
Hybrid strategy

2 deep fields with 2 hrs
total exposure time

3 shallow fields with 40
min total exposure time

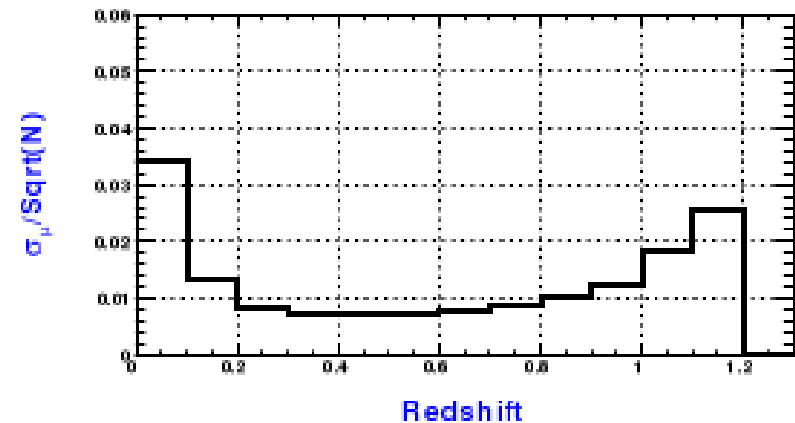
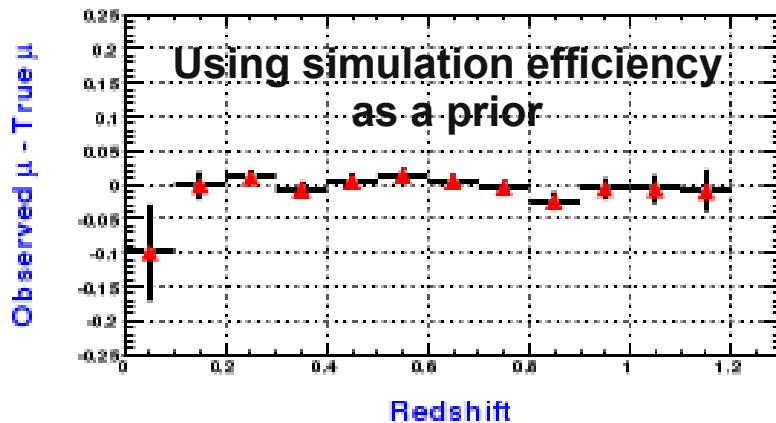
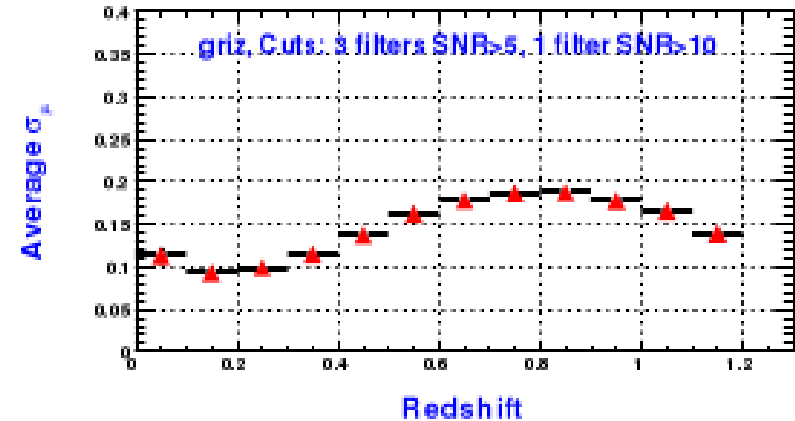
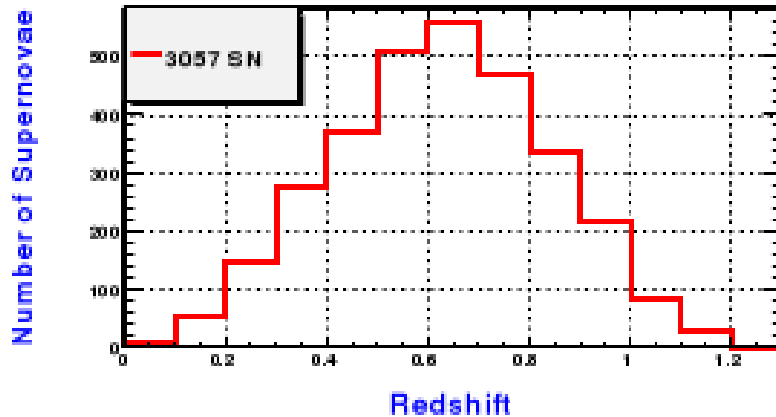


Simulated DES Light Curves



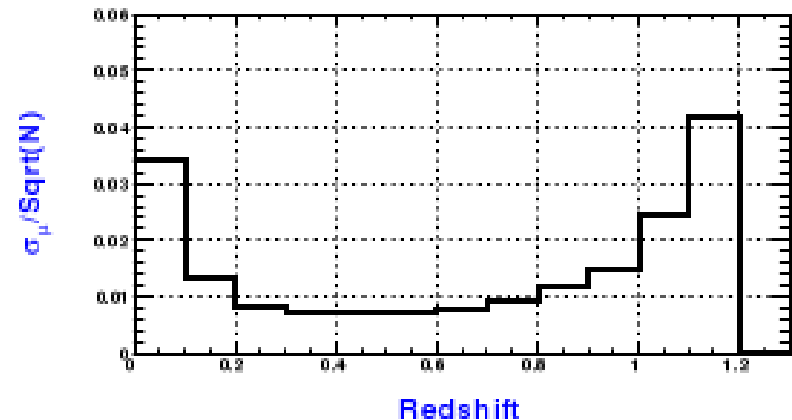
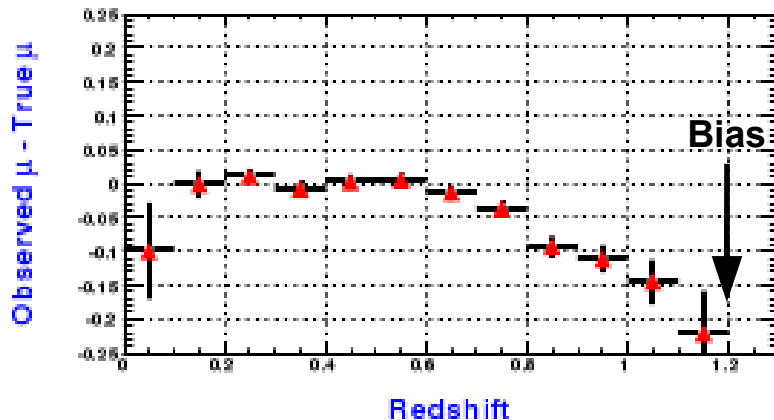
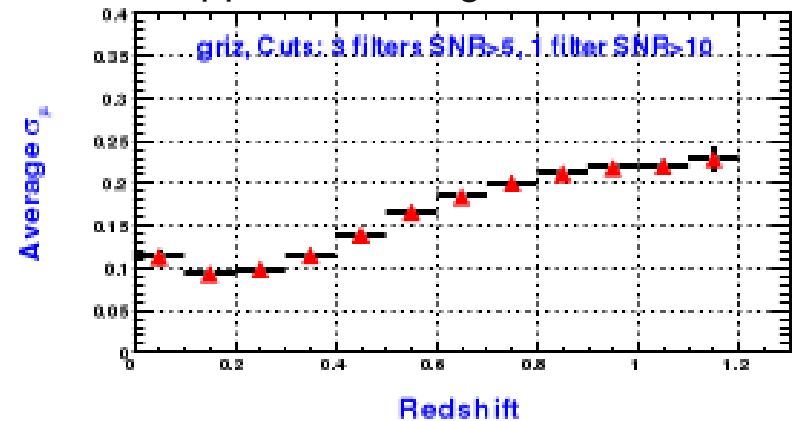
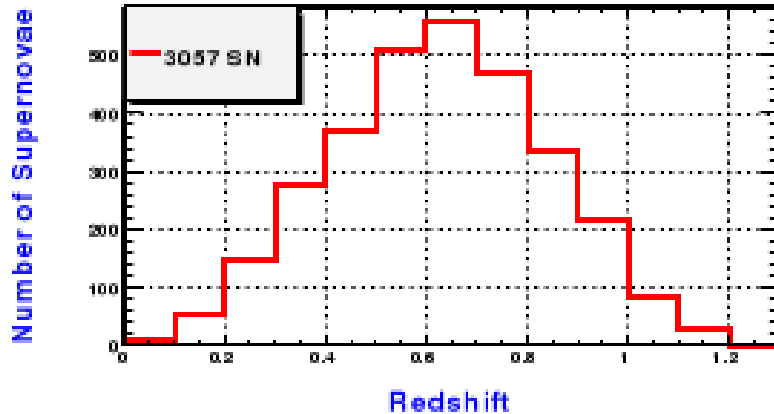
Default Survey: Hybrid griz

Cuts of 1 filter > 10 and any 3 > 5 S/N have been applied for the griz filter set



Bias In μ w/o Simulation Efficiency

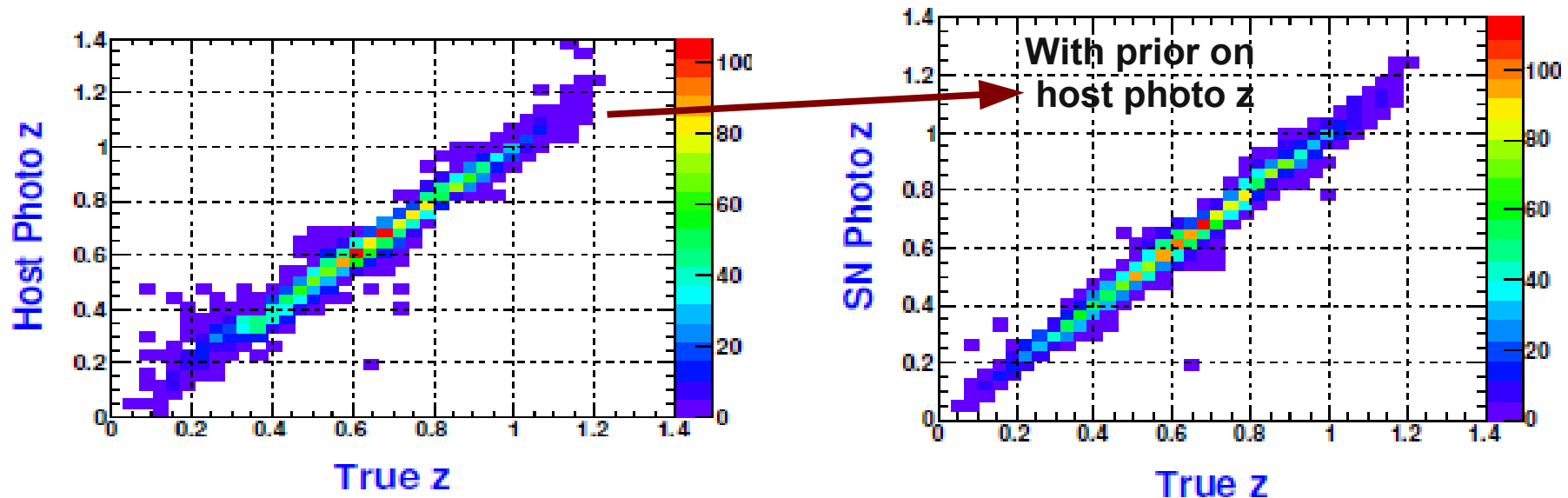
Cuts of 1 filter > 10 and any 3 > 5 S/N have been applied for the griz filter set



A bias in μ is evident in the difference in the fitted and simulated values arises when selection efficiencies are not taken into account and illustrates the magnitude of the μ -correction that will be needed.

Spectroscopic and Photometric Redshifts

- Default spectroscopic follow-up plan is 10 – 25% SN + 100% host galaxy
- While host galaxy follow-up is in progress, use photometric redshifts

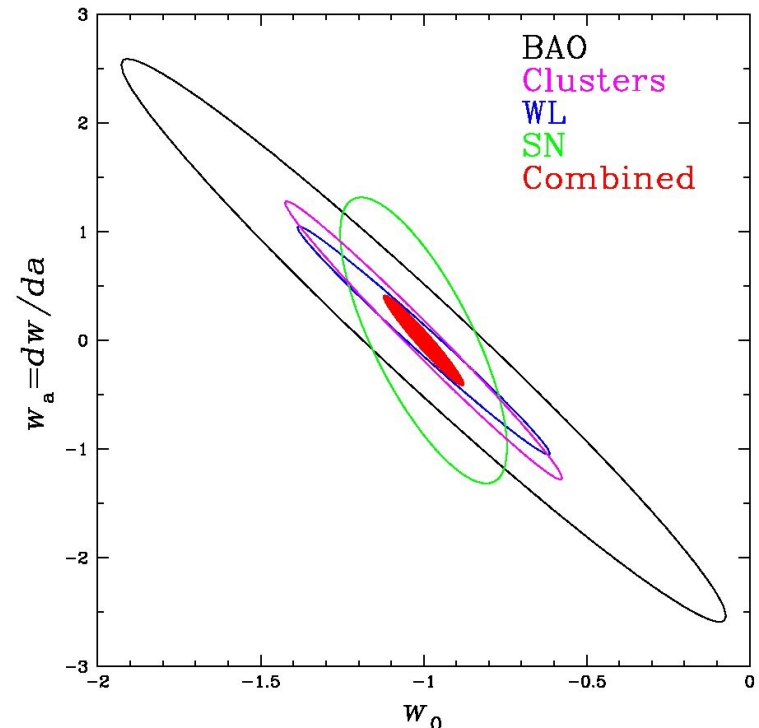


Survey Figure Of Merit (FoM)

- Dark Energy Task Force (DETF) FoM: inverse size of $w_a - w_o$ error ellipse

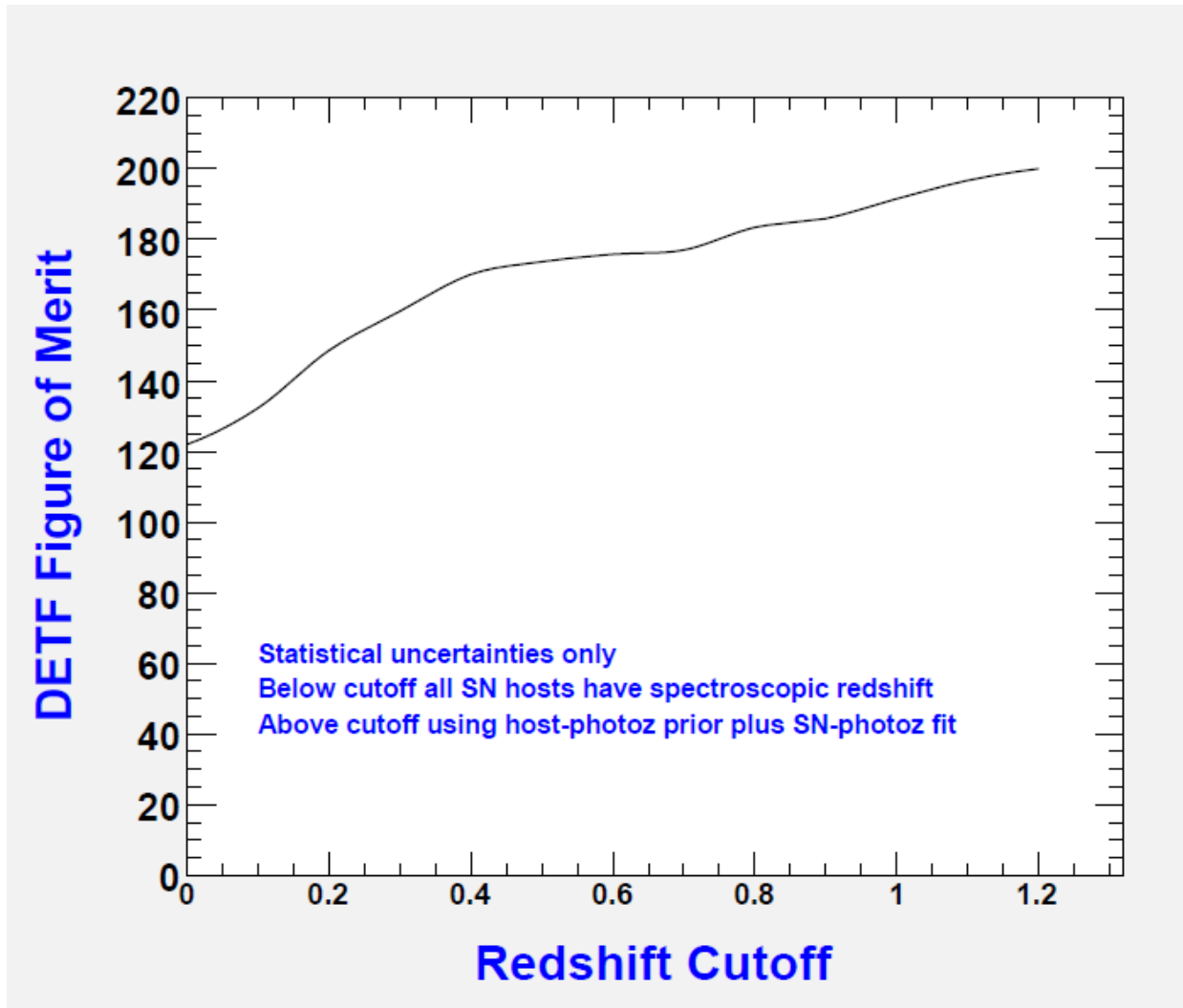
- $w(a) = w_o + (1-a) w_a$
- a = scale factor
- w_o = w at present epoch
- w_a = rate of change of w with a

- Inverse area means bigger is better



Four DES methods to constrain dark energy (plot from NSF/DOE proposal including Planck priors but NOT the DETF Stage II constraints)

DETF FoM vs. Host Spectroscopic z Cutoff



Systematics Studies and Conclusions

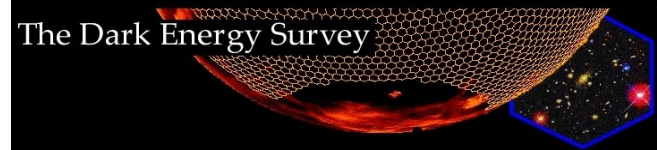
■ Systematics

- zeropoint shift in r-band by 0.1 (expected shift 10x smaller) gives $\Delta\mu$ of 0.04 to -0.16 from $z = 0.0$ to 1.2 (Ribamar Reis)
- filter centroid shifts have negligible effect (Ribamar Reis)
- is DES sensitive to a progressive change in R_V & A_V with redshift?
- is SDSS near-by griz SN sample a sufficient anchor?
- effect of non-Ia contamination?

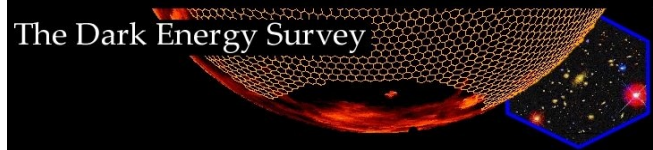
■ Conclusions

- DES SN strategy is coming into focus
- DES SN whitepaper currently in draft form
- systematics studies underway

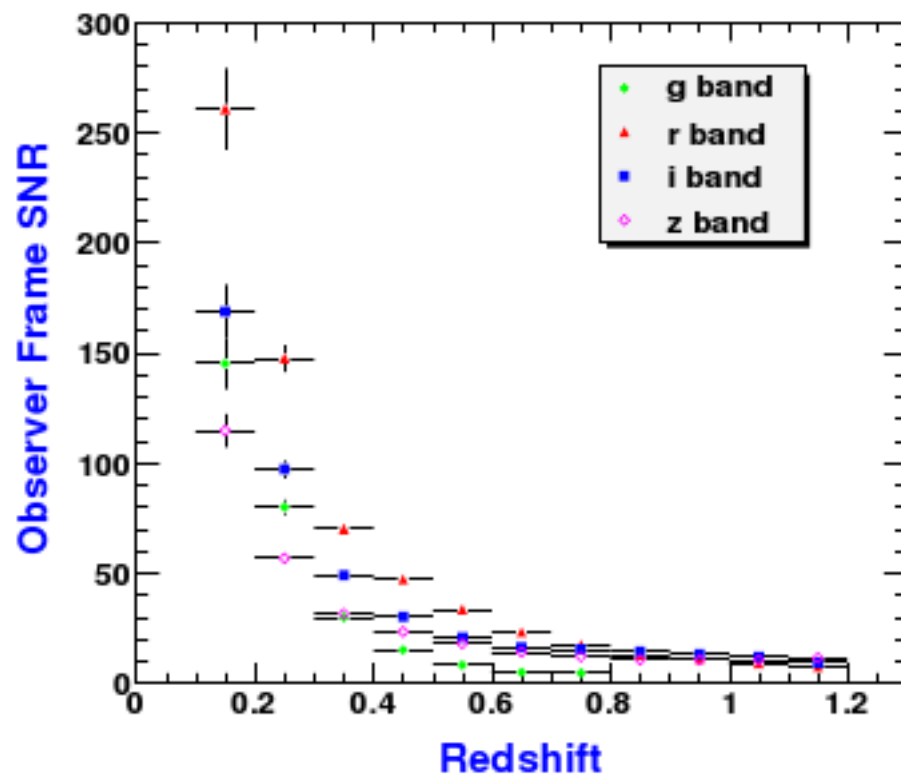
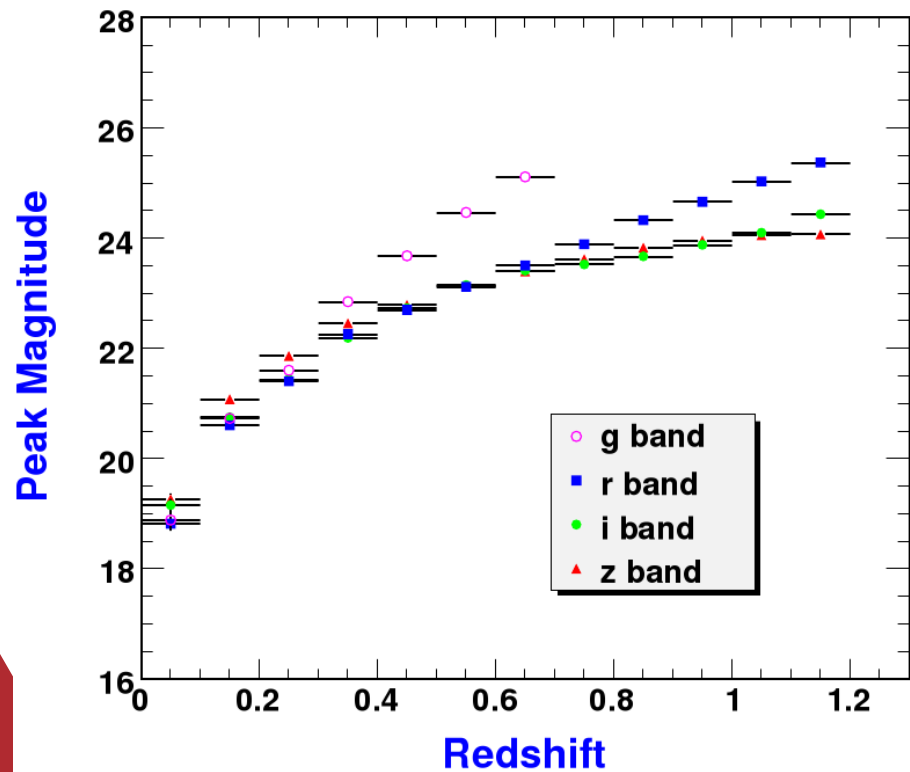
Backup Slides



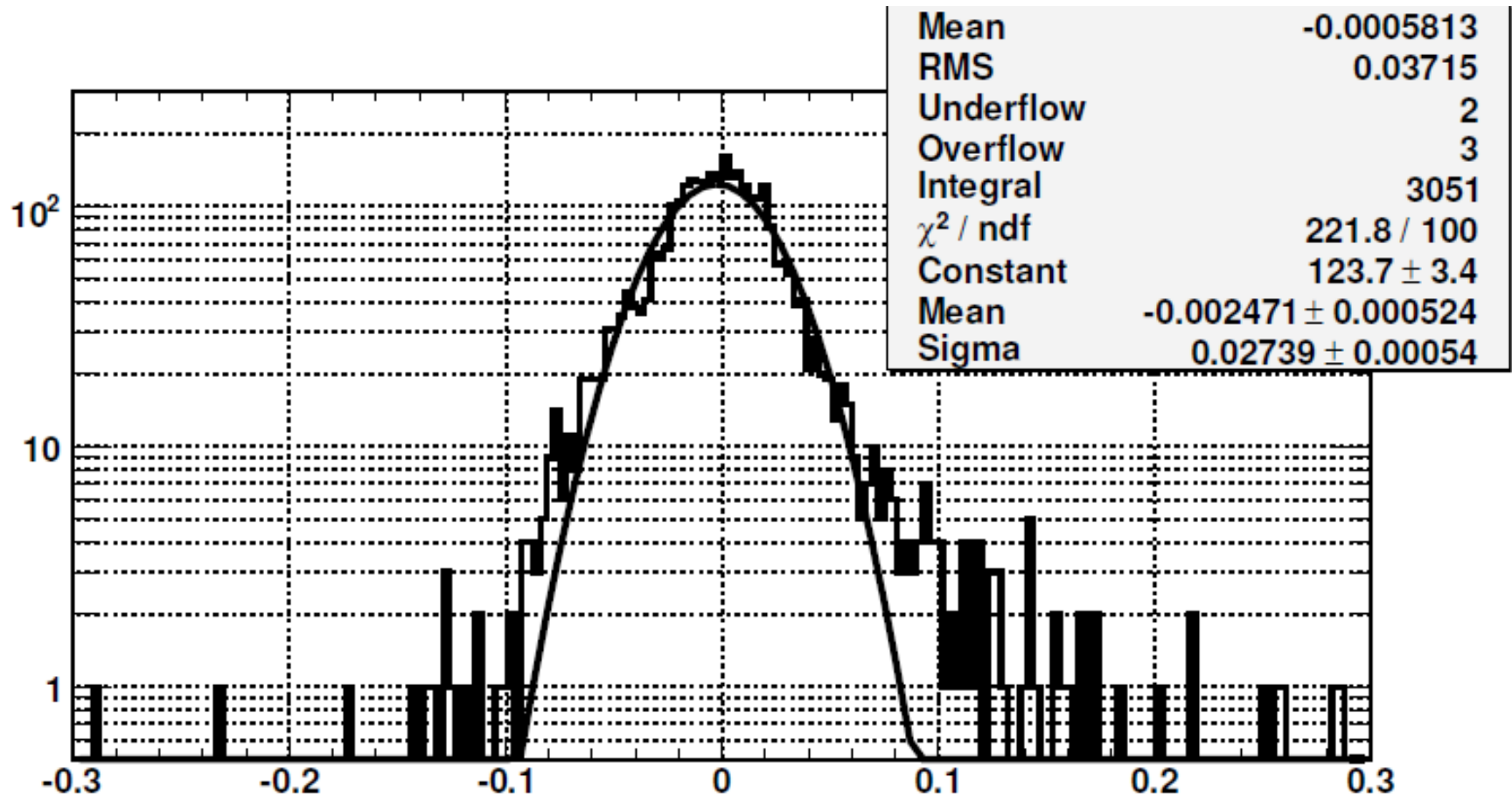
Peak Magnitudes & Maximum S/N



Hybrid (15 sq. deg) griz – cuts of 1
filter > 10 and any 3 > 5 S/N

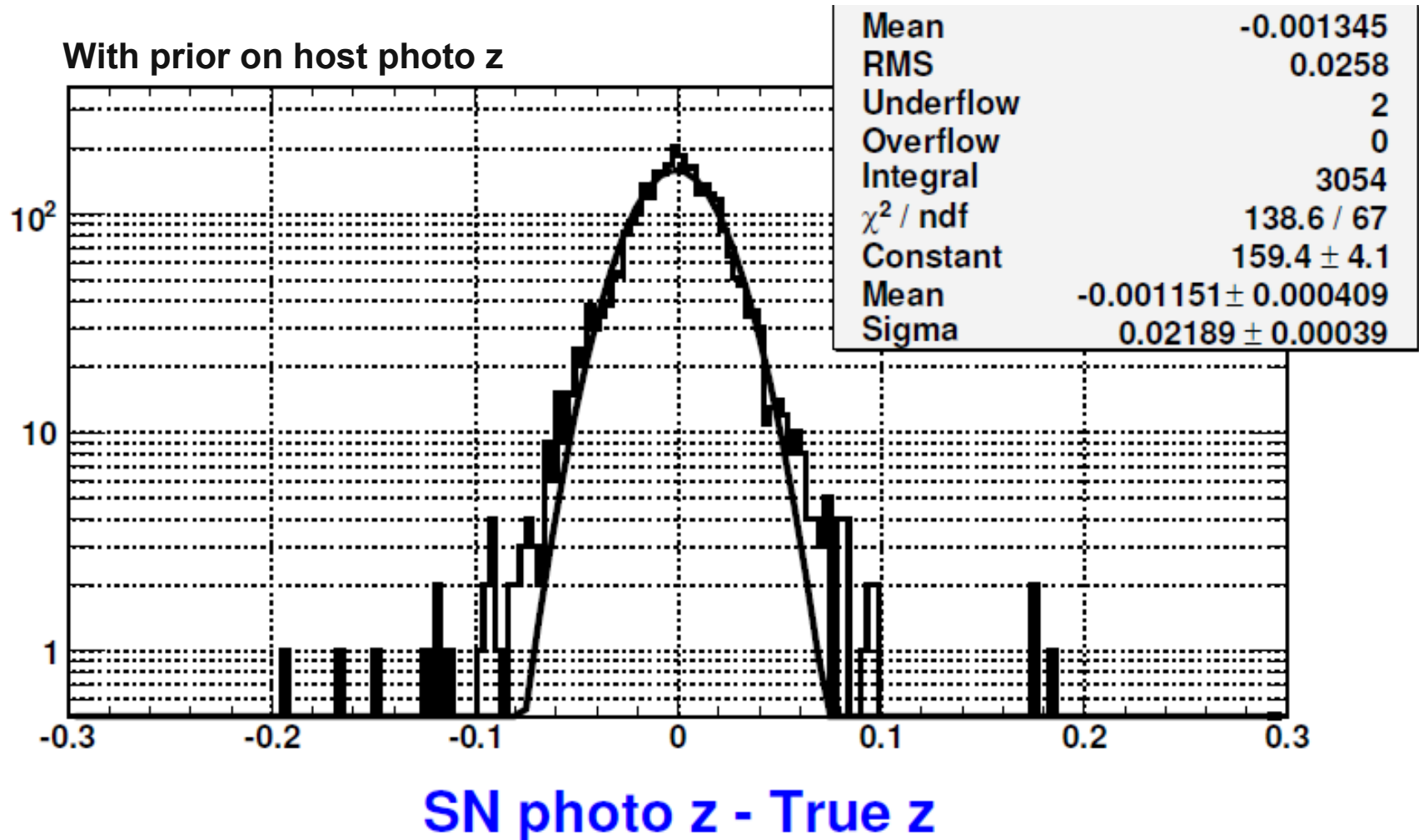


Photometric Redshifts: Host z

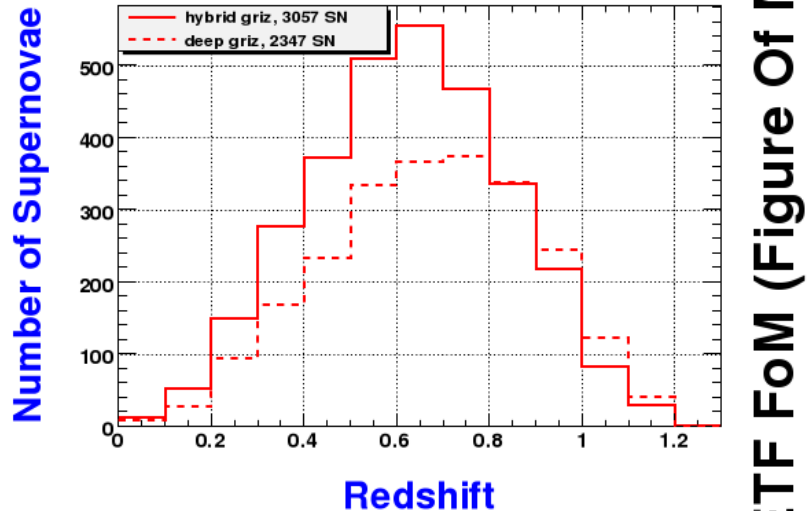


Host photo z - True z

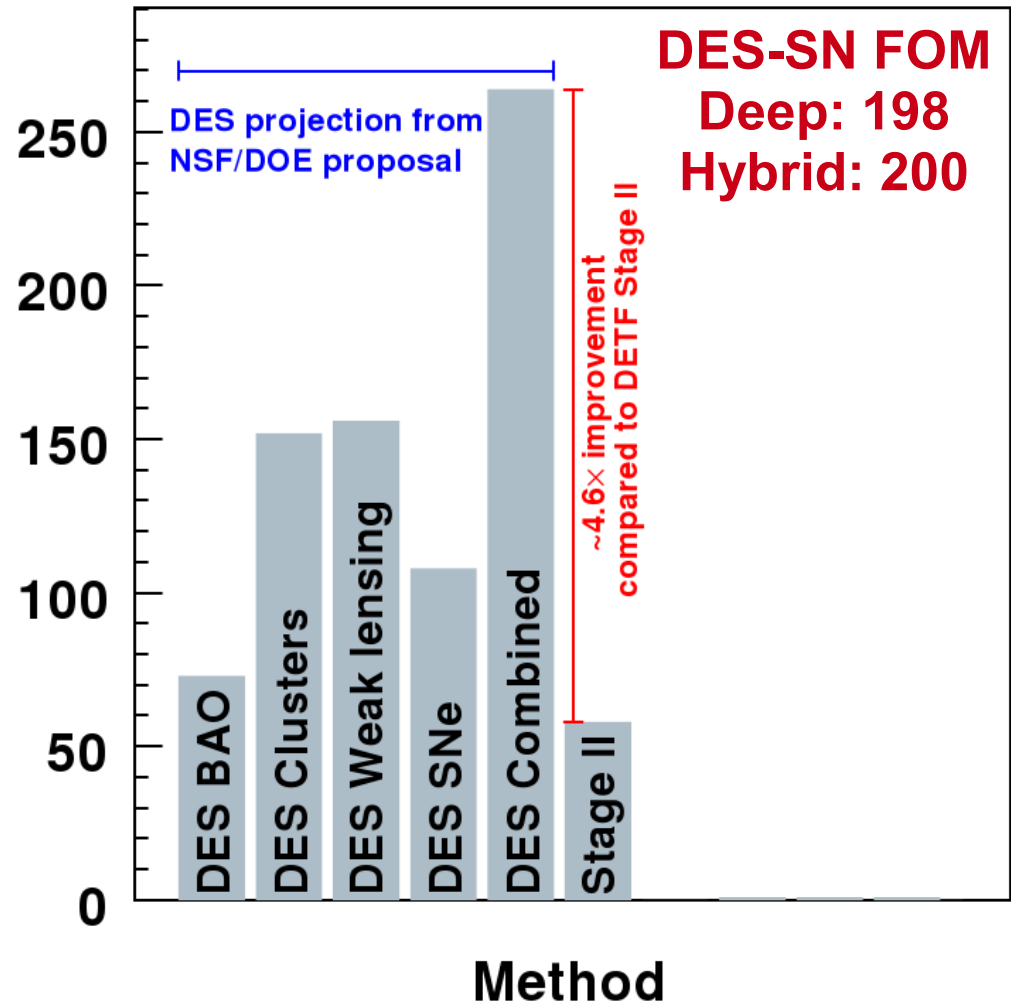
Photometric Redshifts: SN z



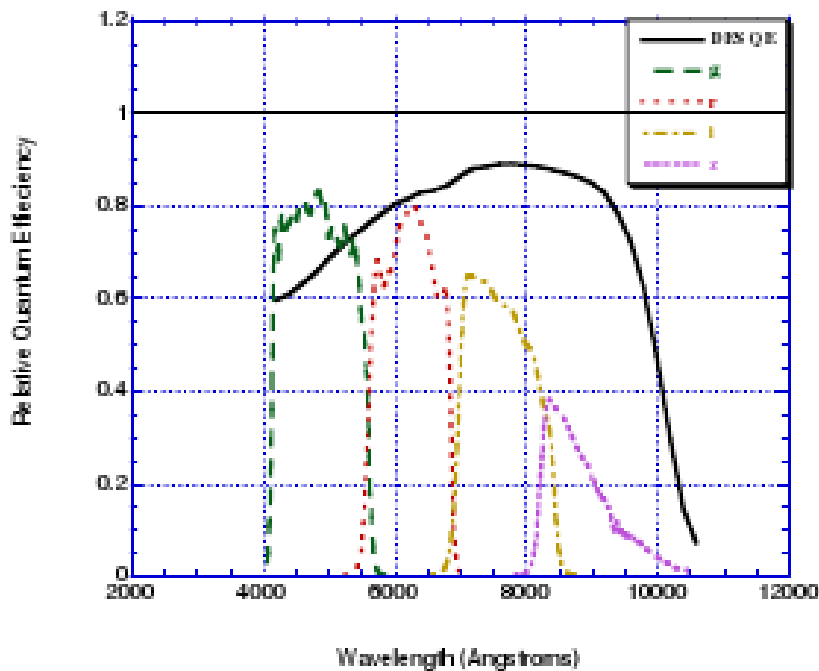
DETF FoM for DES



DETF FoM (Figure Of Merit)



DES vs. SNLS: QE and FOV



DES field of view: 3 square degrees

SNLS field of view: 1 square degree